CR 93.004

NCEL

Contract Report

August 1993

An Investigation Conducted by
Battelle
Columbus, Ohio and
the Naval Civil Engineering Laboratory

FIELD DEMONSTRATION OF A SIEVING AND STABILIZATION TECHNOLOGY ON LEAD-CONTAMINATED SOILS AT A SMALL ARMS RANGE - MAYPORT NAVAL AIR STATION

Abstract One source of environmental heavy metal contamination is impact berms at small ranges. Soils used to capture the bullets can accumulate lead in excess of the RCRA hazardous waste limits. This report describes a method to recover and recycle the lead bullets screened from the soil and to treat the soil to reduce the leachability of the remaining lead contamination. A field demonstration using a stabilization process based on a sclubie silicate and cement formulation was conducted to evaluate the chemical effectiveness of this technology and the ability to reuse the stabilized soil to capture bullets in the impact berm.

NAVAL CIVIL ENGINEERING LABORATORY PORT HUENEME CALIFORNIA 93043-4328

METRIC CONVERSION FACTORS

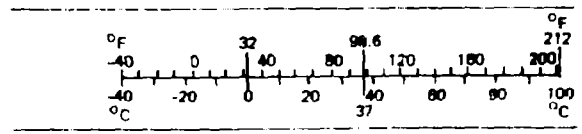
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2,000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures. Price $2.25, SD Catalog No. C13.10:286

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1,000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-018

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	August 1993	Final; February 1990 thru February 1991

4. TITLE AND SUBTITLE FIELD DEMONSTRATION OF A SIEVING AND STABILIZATION TECHNOLOGY ON LEAD-CONTAMINATED SOILS AT A SMALL ARMS RANGE AT MAYPORT NAVAL AIR STATION

5. FUNDING NUMBERS
PR - Y0817-004-71-093
TA - 90-537

6. AUTHOR(S)
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8. PERFORMING ORGANIZATION REPORT NUMBER
CR 93.004

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
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Mayport, FL 32228-0067

Naval Civil Engineering Laboratory
Environmental Restoration and
Utilities Division/Code L71
Port Hueneme, CA 93043-4328

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES
*B. Nelson and J. C. Heath are with the Naval Civil Engineering Laboratory.

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

One source of environmental heavy metal contamination is impact berms at small arms ranges. Soils used to capture the bullets can accumulate lead in excess of the RCRA hazarous waste limits. This report describes a method to recover and recycle the lead bullets screened from the soil and to treat the soil to reduce the leachability of the remaining lead contamination. A field demonstration using a stabilization process based on a soluble silicate and cement formulation was conducted to evaluate the chemical effectiveness of this technology and the ability to reuse the stabilized soil to capture bullets in the impact berm.

14. SUBJECT TERMS
Stabilization, rifle ranges, small arms ranges, lead, heavy metals, chemical fixation stabilization

15. NUMBER OF PAGES
20

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	UL

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

FINAL REPORT

on

FIELD DEMONSTRATION OF A SIEVING AND STABILIZATION TECHNOLOGY ON LEAD-CONTAMINATED SOILS AT A SMALL ARMS RANGE AT MAYPORT NAVAL AIR STATION

to

NAVAL CIVIL ENGINEERING LABORATORIES

February 11, 1991

1.0 INTRODUCTION

This study was conducted for the U.S. Naval Civil Engineering Laboratory (NCEL) in Port Hueneme, California to demonstrate and evaluate the effectiveness of a sieving and stabilization process in treating soils at the small arms range at Mayport Naval Air Station, Mayport, Florida. The U.S. Naval Civil Engineering Laboratory (NCEL) coordinates projects involving the storage, treatment, and disposal of hazardous waste, and decontamination of groundwater and soil at various sites on Naval bases and stations. The Comprehensive Environmental Response Compensation and Liability Act (CERCLA), the Superfund Amendments and Reauthorization Act (SARA), and the Resource Conservation and Recovery Act (RCRA) require the Navy to clean up hazardous wastes that have been released in the past and to minimize the amount of hazardous waste that is currently produced. Treatability tests and a field demonstration of the stabilization process were conducted by ToxCo, Inc., of Claremont, California. Battelle's responsibilities included serving as third party witness to the excavation and treatment activities, conducting chemical analyses of both the treated and untreated soils to evaluate the effectiveness of the stabilization treatment method, and writing the final report.

Lead (Pb) shot accumulates in small arms practice range berm soils and over time creates a safety hazard due to ricochet and a pollution hazard due to the possible release of lead into groundwater and other environmental pathways. Other metals of possible concern were copper (Cu) and zinc (Zn) from the brass coatings on the lead shot. The objective of this task was to demonstrate and evaluate the effectiveness of a sieving and stabilization process in treating soils at small arms ranges to temporarily eliminate

ricochet and hazardous waste characteristics (specifically, toxicity characteristic due to lead leaching).

Mayport Naval Air Stations small arms range was the subject of this study. The soil impact berm measures approximately 92 feet across and was between seven and seven-and-one-half feet in height. The slope of the berm measures 18 feet from the base to the top. Weapons discharged on this range include shot guns, M-14, M-16, M-60, 45-caliber pistol and 38-caliber pistol. The actual age of the range is unknown. Also, any past maintenance activities on the impact berm are uncertain, however, we were informed by the activity that soil had been added to the berm in the past.

2.0 SAMPLING AND ANALYSIS PROGRAM

To establish a baseline concentration for the three metals of concern (Pb, Cu, and Zn) in the soil before treatment, Battelle coordinated the collection and chemical analysis of 30 different berm soil samples and one blind replicate. These samples were obtained from six one-foot depth intervals from five different sampling points in the target butt. Exact sampling locations were determined in conjunction with Navy personnel during the field sampling (see Figure 1).

Three horizontal cores were collected at range position number four, one in the bullet pocket approximately 13 feet up the slope of the target butt, one at six feet up the slope, and another at 17 feet up the slope from the base of the target butt. A total of 18 samples were collected from position number four. Another horizontal core was collected in the bullet pocket area at range position number eight. It was collected approximately 13 feet from the base up the slope of the target butt. The final group of samples were collected at range position number six. A vertical core was made from the top of the soil berm approximately three feet in front of the base of the wooden backstop.

All samples were collected using a stainless steel sand auger and collected in one-foot intervals. Each one-foot interval represents one sample. Each one-foot interval of soil was placed in a non-metallic container and composited and then placed in an appropriate labeled sample container. Chain-of-custody forms were filled out for each sample and shipped with the samples to the laboratory for analysis.

SAMPLE LOCATIONS

(before excavation)

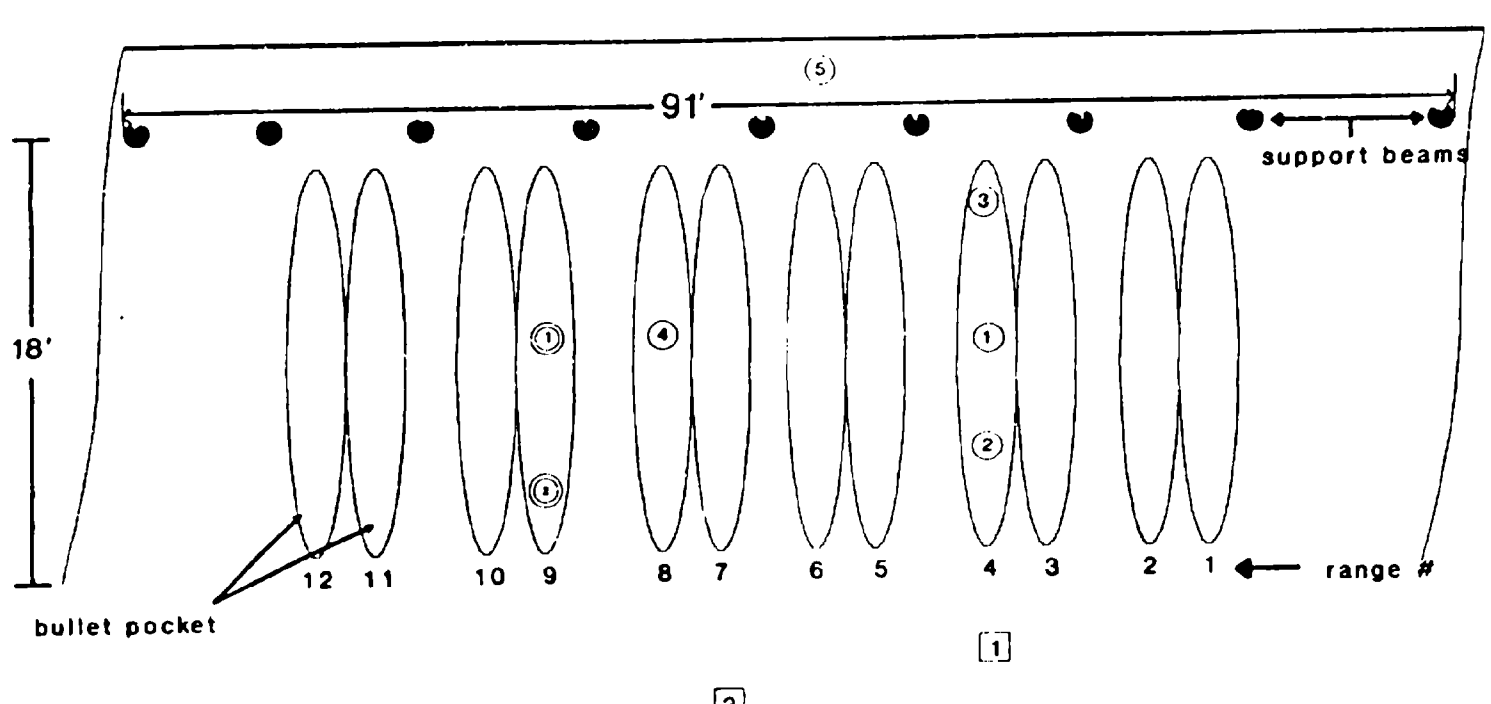


FIGURE 1. SAMPLING LOCATIONS FOR CHARACTERIZATION OF BERM SOIL

Battelle was responsible for performing the chemical analyses on the berm soil samples. Chemical analyses include total Cu, Pb, and Zn and Toxicity Characteristic Leaching Procedure (TCLP)-extractable Cu, Pb, and Zn. Six of the samples were analyzed for pH. A split from each sample collected was provided to the Navy.

3.0 TREATABILITY STUDY

The bench-scale treatment phase involved evaluating a soluble silicate- and cement-based process. ToxCo Inc. in Anaheim, California was provided with four grab samples from the subject small arms range by the Navy prior to the sampling discussed in the sampling and analysis program in Section 2.0. The purpose was to determine if the chemical fixation process could lower the soluble Pb concentration below the EPA threshold limits, thus rendering the soil nonhazardous. The soil samples were first screened to remove rocks and large bullet fragments. The untreated soil was sent to Truesdail Laboratories in Tustin, California to be tested for total and TCLP-soluble Cu and Pb levels. Lead exceeded its TCLP limit of 5.0 milligrams per liter, therefore the berm soil failed the TCLP test for Pb. Note that Cu is not a TCLP-metal, but was analyzed in conjunction with Pb for research purposes.

The silicate/cement treatment was applied to each soil sample, and the treated samples were then analyzed for TCLP Cu and Pb levels. The process used was: a) 250 grams of soil was placed in a large beaker; b) five grams of sodium silicate was added to the waste and mixed; c) a total of 70 grams of water along with a trace of detergent was added to the beaker and again mixed; and d) finally, 62½ grams of low alkaline cement were added to the waste and thoroughly mixed.

The results of the TCLP extraction showed that after treatment, the TCLP Pb concentrations were well below the TCLP limit of 5.0 milligrams per liter. The results are presented in Table 1. The physical characteristics of the treated material were similar to the starting material, and therefore it was concluded that the treated material would have suitable physical properties for re-use as berm soil without causing ricochet problems.

TABLE 1. BENCH-SCALE TEST DATA

Metal	Sample 1	Sample 2	Sample 3	Sample 4
	Total Metals Concentration Untreated Soil (mg/kg)			
Lead	2,120	25,900	6,600	4,390
Copper	87.3	410	255	163
	TCLP Metals Untreated Soil (mg/l)			
Lead	154	661	519	133
Copper	2.4	0.3	2.4	2.5
	TCLP Metals Treated Soil (mg/l)			
Lead	<0.1	<0.1	0.16	2.1
Copper	<0.1	0.14	0.17	0.17

4.0 FIELD DEMONSTRATION

4.1 Initial Soil Sampling

As indicated in Section 2.0, 30 different berm soil samples were collected and chemically analyzed before the excavation of the berm for treatment in order to provide a characterization of the extent of metals contamination in the berm. Figure 1 identifies sample locations. The results of the chemical analyses are presented in Table 2. All analytical tests were performed by Battelle in Columbus, Ohio.

4.2 Pilot Test Preparation

Before starting the pilot tests, Toxco constructed a sieve using 1/4" screen mesh and 2" x 6" wooden frame. The dimension of the sieve was approximately 8' x 8'. The sieve set at a 60 degree angle which would allow the bullets to roll off.

Next, a path approximately three-feet deep leading back to the berm was excavated. The path was necessary to allow the front-end loader and backhoe to pass under overhead framework which covered most of the range and extended into the side berm.

The berm was excavated with a front-end loader and backhoe. Approximately four to five feet of soil were removed from the face of the berm and transported to the sieve in a flat working area in front of the range. The soil was placed on the sieve by a front-end loader. Rakes and shovels were used to help clear the bullets off the screen. The 1/4" mesh became clogged, and a 1/2" mesh screen was tested. The 1/2" mesh screen rejected most of the bullets and rocks and was used to sieve the remaining soil. The sieved soil was then stockpiled on plastic. Six samples of sieved soil were analyzed for total and TCLP lead, copper, and zinc. Table 3 presents the results of these analyses.

TABLE 2. CHARACTERIZATION OF UNTREATED SOIL BERM FOR Pb, Cu, AND Zn

Sample Identification	Total Metal Concentration (mg/kg)				TCLP Metal Concentration (mg/L)			
	Pb	Cu	Zn	pH 1:1	Pb	Cu	Zn	pH of Extract
1-0-1	5,800	110	17	--	250	2.0	0.5	5.18
1-1-2	14,200	260	40	--	470	1.8	1.2	5.33
1-2-3	16,200	468	68	--	100	1.3	1.6	5.65
1-3-4	9,200	125	26	--	445	2.0	1.1	5.29
1-4-5	1,740	3,740	218	8.67	100	0.6	0.2	5.13
1-5-6	1,985	21	4	8.74	36	0.7	0.1	5.19
1-5-6 Dup.	280	13	3	--	--	--	--	--
2-0-1	42,400	65,000	4,200	--	720	0.5	3.6	5.38
2-1-2	34,600	1,200	180	--	450	0.7	4.1	5.43
2-2-3	4,000	320	56	--	285	7	1.9	5.34
2-3-4	8,200	348	59	--	70	4.8	1.6	5.70
2-4-5	3,450	60	14	8.66	200	2.0	0.4	5.18
2-5-6	40	4	2	8.83	4.0	0.1	<.1	5.20
2-5-6 Dup.	44	4	2	--	--	--	--	--
3-0-1	2,500	30	2	--	28.9	0.2	<0.2	5.70
3-1-2	50	4	<2	--	0.9	0.04	<0.2	6.18
3-2-3	269	8.3	7.7	--	14	0.2	<0.1	6.07
3-3-4	11,500	230	40	--	48	0.8	1.1	5.75
3-4-5	9,400	72	19	--	150	1.0	0.5	5.61
3-5-6	470	13	5	8.53	165	0.4	0.2	5.40
3-5-6 Dup.	1,000	12	5	--	125	0.4	0.2	5.30
4-0-1	16,600	8,100	900	--	550	1.9	1.3	5.34
4-1-2	4,400	140	18	--	88.4	2.0	0.5	5.60
4-1-2 Dup.	4,800	150	20	--	91.9	2.1	0.7	5.64
4-2-3	38,800	132	28	--	107	1.9	0.6	5.90

TABLE 2. CHARACTERIZATION OF UNTREATED SOIL BERM FOR Pb, Cu, AND Zn (Continued)

Sample Identification	Total Metal Concentration (mg/kg)				TCLP Metal Concentration (mg/L)			
	Pb	Cu	Zn	pH 1:1	Pb	Cu	Zn	pH of Extract
4-2-3 Dup.	6,580	118	26	--	--	--	--	--
4-3-4	2,490	126	32	--	90	0.9	0.6	5.56
4-4-5	10,600	660	72	--	100	0.9	0.4	5.65
4-5-6	4,530	2,380	237	8.40	235	1.0	0.4	5.30
4-5-6 Dup.	3,150	80	21	--	--	--	--	--
5-0-1	16,000	220	26	--	104	1.4	0.6	5.66
5-1-2	15,000	90	12	--	220	0.8	0.2	5.49
5-2-3	370	10	<2	--	30.1	0.2	<0.2	5.34
5-3-4	1,460	14	<2	--	36.7	0.3	<0.2	5.28
5-4-5	790	300	27	--	85.4	0.5	<0.2	5.50
5-5-6	940	10	<2	--	53.9	0.5	0.4	5.29
5-5-6 Dup.	325	20	<2	--	62.1	0.3	<0.2	5.21

Note on Sample Identification
1st digit is sample location
2nd and 3rd digits are the depth interval in feet.

TABLE 3. TREATABILITY DATA ON PILOT TEST RUNS NOS. 1, 2, 5, and 6

Sample Identification	Total Metal Concentration (mg/kg)				TCLP Metal Concentration (mg/L)			
	Pb	Cu	Zn	pH 1:1	Pb	Cu	Zn	pH of Extract
Sieved Soil - Untreated								
1-S	23,500	10,400	1,180	8.51	689	3.2	2.7	5.21
2-S	7,950	325	50	8.48	409	3.2	1.5	5.34
3-S	24,800	170	25	8.40	284	1.8	1.2	5.42
4-S	26,100	300	65	8.51	384	3.6	1.6	5.38
5-S	8,300	215	80	8.20	268	2.5	0.8	5.35
6-S	7,250	2,400	280	8.32	326	4.7	1.2	5.30
6-S Dup.	6,350	270	45	--	334	4.2	1.4	5.35
Pilot Test No. 1								
1-PT	15,620	6,520	660	12.51	<.5	<.1	<.1	9.95
2-PT	36,000	380	57	12.34	495	3.6	2.0	5.05
3-PT	9,300	295	43	12.52	1.0	0.1	<.1	8.01
4-PT	31,800	292	46	12.59	150	1.6	1.6	6.20
4-PT Dup.	35,800	2,750	315	--	160	1.8	1.0	6.21
Pilot Test No. 2								
1-PT-2	3,500	100	26	12.58	<.5	<.1	<.1	8.73
2-PT-2	2,600	95	25	12.61	<.5	<.1	<.1	10.95
3-PT-2	6,000	80	26	12.63	<.5	<.1	<.1	11.68
3-PT-2 Dup.	11,800	85	200	--	<.5	<.1	<.1	11.68

TABLE 3. TREATABILITY DATA ON PILOT TEST RUNS NOS. 1, 2, 5, and 6 (Continued)

Sample Identification	Total Metal Concentration (mg/kg) Pb	Cu	Zn	pH 1:1	TCLP Metal Concentration (mg/L) Pb	Cu	Zn	pH of Extract
				Pilot Test No. 5				
** 1-PT-3	3,950	150	140	12.13	0.5	--	--	11.18
* 2-PT-3	11,400	130	130	12.60	0.5	--	--	11.05
* 3-PT-3	13,500	130	130	12.63	0.5	--	--	11.17
				Pilot Test No. 6				
** 1-PT-4	2,750	88	91	11.91	1.4	--	--	11.49
* 2-PT-4	3,700	120	130	12.62	1.3	--	--	11.41
2-PT-4 Dup.	--	--	--	--	1.4	--	--	11.43
* 3-PT-4	2,850	100	100	12.59	1.4	--	--	11.08
* 1-PT-4 Dup.	--	--	--	12.51	--	--	--	--

* pH measurements taken approximately one month after treatment.
** pH measurements taken approximately five days after treatment.

4.3 Pilot Tests

The first pilot test was conducted on October 3, 1990. An approximately 20 cubic yard pile of sieved soil was spread out on plastic on a flat working area in front of the practice range. Water was sprayed on the soil and 55 gallons of sodium silicate were spread over the soil with the bucket of the front-end loader. A large rototiller was then passed over the soil to mix the ingredients. Ten thousand pounds of cement were then applied to the pile by a truck with a metered spray bar on the back. The cement was rototilled into the soil mixture, covered with plastic and allowed to cure overnight.

The rototiller was passed over the treated pile the next day to help break it up. Four samples were taken from the treated pile and analyzed for total and TCLP lead. The analytical results from this pilot test are presented in Table 3 (Pilot Test No. 1). Two of the four samples were above the EPA limit of 5 mg/l for lead. The product from the first pilot test which was conducted to be unsuccessful, was returned to the untreated pile for retreatment, and the area was cleaned up. The unsatisfactory results of the process was attributed to inadequate mixing using the rototiller.

On October 10, 1990 a second pilot test was conducted using a 20-yard capacity roll-off box as a container. First, a seal was placed around the door to prevent leaks. Next, two-and-a-half cubic yards of sieved soil were placed in the roll-off box. A calibrated pump was used to meter ten gallons of sodium silicate solution and 160 gallons of water into the box. The contents of the box were mixed together with a hand-maneuvered rototiller. Next, 1,500 pounds of cement and additional water were added and mixed by rototilling. The amount of cement was metered when discharged from the delivery truck. It took about two-and-a-half hours to treat two-and-a-half cubic yards of soil. The mixture was covered and allowed to cure overnight. Three samples were taken and analyzed for total and TCLP lead. The results are provided in Table 3 (Pilot Test No. 2). These results showed that the stabilization technology worked. However, the mixing process was concluded to be too time-consuming and not cost-effective. Also, the final mixture was hard and difficult to break up, and therefore not desirable for placement back in the berm because of possible ricochet.

On November 28, 1990 the third pilot test was performed. This test was designed to produce a mixture with 20 percent cement, by weight, but due to a mix-up in equipment rental the final mixture contained 60 percent cement. Approximately 2.4 yd^3 of soil was conveyed into a cement truck containing 30 gallons of sodium silicate, 250 gallons of water and a cup of soap. The cement truck remained rotating throughout the whole process. The amount of soil was monitored by counting the number of 1/4 yd^3 back-hoe buckets that were put onto the conveyor belt. The water was metered into the truck at the cement company, and the sodium silicate was metered using a calibrated pump. The first cement truck discharged its content, via a conveyor belt into a second cement truck containing 4400 pounds of cement and 300 gal of water. The cement and water were both added at the cement company. The mixture was discharged into a roll-off box and allowed to cure overnight. One sample was taken from this mixture and the TCLP Pb level was 1.83 mg/l. This mixture was too hard to re-use on the face of the berm. The large pieces were placed at the very bottom of the berm, below the line of fire.

The fourth pilot test was conducted later on November 28. It was designed to have a product with 25 percent by weight of cement but again due to the equipment rental mix-up, it actually yielded a product with 75 percent by weight of cement. The same cement truck process was used but the ingredient amounts were:

2.4 yd^3 soil
30 gal silicate solution
5400 lb cement
500 gal water
1 cup soap

The TCLP Pb level was 1.4 mg/l. Again, the hardened material was placed at the bottom of the berm.

The fifth pilot test was conducted on November 29, 1990 and used the following amounts of ingredients:

7.2 yd^3
30 gal silicate
4400 lb cement
500 gal water
1 cup soap

This mixture corresponds to approximately 20 percent by weight cement. After this mixture cured for 4 hours, the treated soil was mixed up with a backhoe to determine if it would be easier to remove from the roll-off box. This proved to be a very significant step in the pilot test, because the process yielded a treated material that was relatively soft and friable, similar to the untreated berm sand. TCLP data are included in Table 3 (Pilot Test No. 5).

The sixth pilot test was also performed on November 29, 1990 and produced a mixture with 25 percent cement. The ingredient amounts were:

7.2 yd^3 soil
30 gal silicate
5400 lb cement
500 gal water
1 cup soap

Again, the set of the cement was destroyed by mixing the treated grit with a backhoe approximately 4 hours into curing. The analytical results are presented in Table 3.

Because the TCLP results for Pb from the fifth and sixth pilot tests were well below the EPA limit of 5 mg/l, the process (No. 5) using 20 percent cement was selected for the full-scale treatment.

4.4 Full-Scale Treatment

On December 4, 1990 full-scale treatment began. As indicated, the full-scale treatment used the same process and amount of material as the fifth pilot test except with slight variations in the amount of water added to compensate for the variable water content of the berm soil. Also, the mixture was removed from the roll-off box and spread thinly after approximately four hours of curing. The next day it was broken up with the front-end loaders. A total of 12 treated soil samples were collected from the full-scale treatment and analyzed for total and TCLP Pb, Cu, and Zn. See Table 4 for analytical results. All of the samples passed the TCLP Pb criterion by a wide margin.

The treated soil was placed back on the face of the berm using a front end loader and backhoe. Next, a three- to four-inch layer of clean fill was placed over the treated soil on the berm so that the berm could be

TABLE 4. TREATABILITY DATA FROM THE FULL-SCALE TREATMENT

Sample Identification	Total Metal Concentration (mg/kg)				TCLP Metal Concentration (mg/L)			
	Pb	Cu	Zn	pH 1:1	Pb	Cu	Zn	pH of Extract
1-T	14,100	120	110	12.62	<0.1	<.05	<.05	11.19
1-T Dup.	--	--	--	12.64	<0.1	<.05	<.05	11.24
2-T	4,000	110	110	12.59	<0.1	<0.1	<0.1	11.41
3-T	4,500	100	100	12.50	0.2	<0.1	<0.1	11.58
3-T Dup.	10,000	140	140	--	--	--	--	--
4-T	25,000	340	320	12.51	<0.1	<0.1	<0.1	11.50
5-T	9,000	110	120	12.40	<0.1	<0.1	<0.1	10.40
6-T	5,000	--	--	12.43	0.9	<0.1	<0.1	11.99
6-T Dup.	--	--	--	12.51	0.3	<0.1	<0.1	11.91
7-T	5,500	210	200	12.30	<0.1	0.1	0.2	11.53
8-T	20,000	120	130	12.31	<0.1	0.1	<0.1	11.52
9-T	14,000	2,400	2,200	12.32	<0.1	<0.1	<0.1	11.23
10-T	27,000	120	180	12.33	<0.1	<0.1	<0.1	11.20
11-T	13,500	210	210	12.32	<0.1	0.2	0.2	11.03
12-T	7,500	110	110	12.40	<0.1	0.1	0.1	11.59
12-T Dup.	4,000	1,200	1,100	12.41	<0.1	0.1	0.1	11.53

revegetated. The path to the berm was filled and the entire area was hydromulched with a native grass.

The material rejected by the sieve, comprising primarily of bullets, was turned over to the Mayport Morale, Welfare and Recreation Department, at their request, for recycling.

5.0 DISCUSSION AND CONCLUSIONS

5.1 Treatment Cost Analysis

The total cost of the Mayport Small Arms Range Stabilization project was $130K. This included the cost of full-scale treatment (approximately 170 cubic yards), pilot test, mobilization, travel, excavation of the berm, replacement of treated soil on the berm, oversight, planning, and extensive sample analysis. The need for several pilot tests added to the overall cost. Because this was the first time this process was used in the field at a small arms range site, the costs are probably higher than what would be encountered for future projects.

5.2 Process Effectiveness

The stabilization process used in this project produced TCLP Pb values consistently below the EPA limit of 5.0 mg/l. The TCLP levels of the untreated soil were well above 250 mg/l, demonstrating that the stabilization process significantly reduced the leachable lead content.

The use of a 1/2" screen proved satisfactory in sieving out most of the bullets. For large projects, a vibrating screen with 1/2" openings is probably preferable. The vibrating screen would reduce the amount of labor and time needed for sieving, however, dust suppression will likely be necessary.

The use of cement trucks as the mixing device may be employed in projects of similar size, (<300 cubic yards) but a pugmill or similar mixing device with a higher throughput is recommended for larger projects.

5.3 Future Sampling

It is recommended that the berm be sampled once a year to monitor the TCLP Pb lead levels. These samples should be taken from locations each year. Proposed sample locations are illustrated in Figure 2.

Sample location No. 1 is located on the far left side of the berm away from direct fire. One sample should be taken three feet into the berm.

Sample location No. 2 is located in the middle of a bullet pocket. One sample should be taken from three inches below the surface of the berm. This sample will probably show very high levels of lead due to the direct fire.

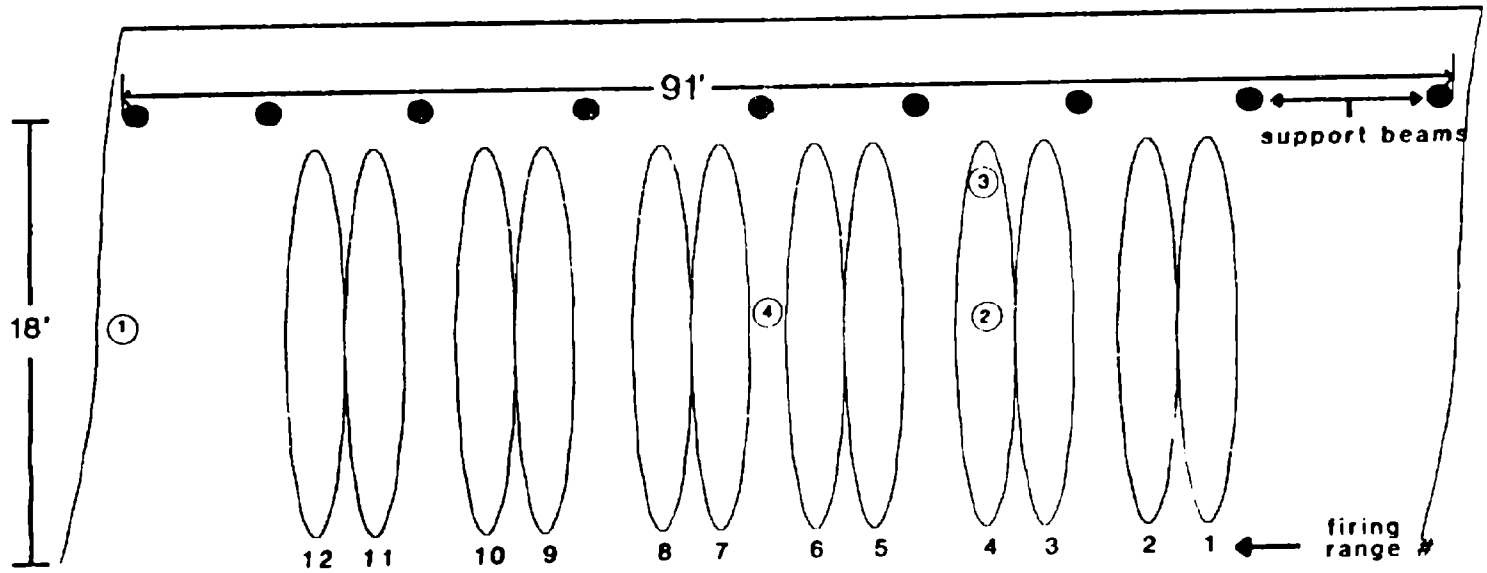
Sample location No. 3 is located above sample location No. 2 but in the same firing line. One sample should be taken three inches below the surface of the berm.

Sample location No. 4 is located between two firing lines. One sample should be taken six inches below the surface of the berm.

All of the samples should be analyzed for total and TCLP Pb.

FUTURE SAMPLE LOCATIONS

(after treatment)



○ sample sites
samples taken once a year

FIGURE 2. RECOMMENDED FUTURE SAMPLE LOCATIONS

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